whole number for the entire season was more than 200,000,000. The three rivers are now yielding from 12,000,000 to 15,000,000 eggs daily. The commission is also giving attention to the moving of eggs and the hatching and planting of young shad in the rivers that flow into the South Atlantic and the Gulf of Mexico: 30,000,000 eggs will be disposed of in this way this season.

Whatever opinion may be held of the other work of the United States Fish Commission (and the importance of all branches of its work is coming to be universally recognized), its success in increasing the supply of shad in the rivers to which it has given its attention, and in introducing it where it did not before exist, has been demonstrated beyond question. The value of shad taken in the United States in 1887 was $325,000 greater than in 1880, and this in spite of the fact that the market-prices of the fish are now much lower than formerly. Shad can be bought on the wharves in Washington for from ten to twelve dollars per hundred, and at retail in the market for twenty-five cents each. Before 1884 the retail price of similar fish was seventy-five cents each. The increase first became noticeable in 1884.

The Water-Spouts of April.

Science republished, about six weeks ago, one of the charts of the Hydrographic Office, showing the location of a great number of water-spouts observed in the western Atlantic in March and early in April. Since that time many more detailed reports have been received; and among them one of the most interesting is that made up from the log of the steamer 'Pavonia,' and from the testimony of eye-witnesses who were on board of her. The following is the substance of that report. The spout formed south-west of the ship, and travelled in a north-east direction, making it necessary for the 'Pavonia' to change her course in order to avoid it. Its movement was at the rate of thirty miles an hour; and from the time it was first seen, until it burst near the vessel, only ten minutes elapsed. Its rotary motion was against that of the sun. The agitation of the sea at the base was tremendous, so that the ship was greatly affected by it when the water-spout passed near. The wind at the time was a light breeze from the south. As the water-spout passed, the ship experienced a perfect whirlwind for about a minute. The water-spout broke off the starboard bow, and this was accompanied by a great deluge of rain, vivid lightning, and heavy thunder; and chunks of ice fell upon the decks of the 'Pavonia,' irregular in shape, as though broken from a block, many of them from four to six inches in diameter. As the water-spout broke, the wind shifted to the south-west, and increased to a moderate gale. The cloud hung very low, and the water-spout took the form of an hour-glass. A terrific roaring noise was heard as it passed the ship, and, as it went along, it threw the water to a height of sixty feet at least, and churned it up into a mass of foam. There was no evidence of ascending or descending currents. The water appeared to be lifted bodily into the air, and held there until the water-spout broke near the vessel. No observations of barometer or thermometer were made.

United States Fish Commission Work on the Pacific Coast.

The United States Fish Commission steamer 'Albatross,' Capt. Z. L. Tanner, arrived at San Francisco last week, and, as soon as she is fitted out, will start on her summer cruise. She has been ordered to cruise from Kodiac to and along the Aleutian Islands, for the purpose of studying the fishing-grounds of the Alaskan coast. The most important fish found there is the cod. Captain Tanner is instructed to make a careful and systematic study of the whole coast, not only hydrographically, but for the purpose of determining the kinds of fish to be found there, the limits of their distribution, and their abundance. He is also to make a thorough study of the fauna of the sea and its distribution over the sea-bottom. Important results are anticipated from this summer's cruise of the 'Albatross.'

ELECTRICAL SCIENCE.

Edison's Improved Phonograph.

THE first phonograph made by Edison, in 1878, differed from many inventions — for example, the telephone and telegraph — in that it was not the result of a process of evolution, and it was not almost simultaneously discovered by different investigators. As it was first exhibited, it consisted of a diaphragm to which was fastened a needle whose point pressed against a strip of tinfoil: the tinfoil was rolled around a cylinder, which was rotated by hand, and which had, besides its motion of rotation, a forward motion on a screw, so that the needle traced a spiral on the surface of the foil. When the diaphragm was spoken to, the cylinder being at the same time turned, the needle made a record on the foil; the number and depth of its indentations depending, of course, on the vibration of the diaphragm, and therefore on the sound it received. When the needle was made to traverse the record again, it transmitted vibrations to the diaphragm similar to those it had received, reproducing the original sound. There were several disadvantages in this first instrument: the reproduction was by no means perfect, and the mechanical arrangement was not convenient. Mr. Edison has, however, continued his investigations on the subject, and has lately produced an instrument that leaves little to be desired as far as faithfulness of reproduction goes. There is no radical change in principle. In place of the tinfoil, wax cylinders are used, and they are uniformly rotated by an electric motor. The instrument is so arranged that words can be repeated that are not understood. The wax cylinders are of different sizes. One of two inches in diameter, four and a half inches in length, and one-eighth of an inch thick, will contain from one thousand to twelve hundred words, and can be used over ten or twelve times, a turning-tool in front of the diaphragm shaving off the old record. The accuracy with which sounds, vocal and instrumental, are reproduced is remarkable. On May 12 an exhibition of the phonograph was given at the New York Electric Club, and Mr. Gilliland described the history of the invention. Various applications were shown, and a number of different sounds reproduced. There is no doubt that the phonograph can accurately record all varieties of sound, from the human voice in ordinary conversation to a brilliant piano concert. The records are portable and easily reproduced, and the field of application of the instrument must be wide.

DYNAMO AND STEAM TURBINE. — A combined dynamo and steam turbine that has been in use in England for some time, has recently been introduced into the United States for ship-lighting purposes by the United States naval authorities at Newport, R.I. The armature of the dynamo is connected directly to the shaft of the turbine, which revolves at the extremely rapid rate of ten thousand revolutions per minute. The turbine works on the general principle of Helmholtz's double siren, except that instead of two disks there are perhaps fifty, arranged on horizontal axes; the steam entering at the middle, and exhausting at the ends. While this is in all probability not economical, it is extremely compact, — a very important consideration on board ship, where space is valuable and belting is objectionable. The electro-motive force of the dynamo is kept constant by an electric governor which regulates the throttle valve of the turbine. The extremely high speed necessitates the best possible lubrication: the bearings are long, with ample oil-channels.

PRIESTMAN'S PETROLEUM-ENGINE. — The London *Electrical Review* contains reports of tests of this engine made by Sir William Thomson, Sir Samuel Canning, and others. The reports are most flattering. Tests were made of engines giving six-horse power at the driving-pulley, with the result that the consumption of oil was about 1.7 pints per horse-power per hour, while they need very little attention. To quote a part of Sir Samuel Canning's report: "We consider that there is a great field of usefulness for this motor, and especially in America, where gas averages something like 7s. 6d. per thousand cubic feet, and where, owing to the vast expanse of the country, it is very difficult to get motive power in more or less inaccessible localities; . . . for isolated electric light installations, and even larger operations of the kind, and for every use to which a gas-engine can be put, with the special advantage of being capable of employment where gas cannot be utilized." The engine is run by the petroleum vapor, which is exploded in the cylinder, as is the gas in the cylinder of a gas-engine. There must, of course, be a water-jacket to the cylinder, to prevent excessive and dangerous heating. Let us consider what the cost of isolated lighting would be, using this engine, as compared with gas. An

ordinary gas-burner uses over six feet of gas per hour: one mechanical horse-power at our oil-engine can supply twelve corresponding incandescent electric lights; or 1.7 pints of oil must be compared with 72 feet of gas; roughly, 24 pints of oil will equal 1,000 feet of gas. The quality of oil used cannot cost as much as ten cents per gallon: at that price the oil for our engine will compare with gas at thirty cents per thousand. To this we must add about fifteen cents for breakage of lamps, making forty-five cents per thousand. The amount to be added for interest and deterioration depends entirely upon the amount of light used: for an ordinary household, using four or five thousand feet of gas a month, this item might amount to a dollar a thousand at a very liberal estimate, making the total cost one dollar and forty-five cents a thousand at the outside, and giving all the advantages that incandescent lighting offers, — greater health, convenience, comfort, and beauty, with the use of small motors for various domestic purposes.

ACCUMULATOR TESTS. — The London *Electrician* contains the following: "Prof. von Waldenhofen has recently carried out at the Electro-Technical Institute a comprehensive series of experiments with the storage-cells of the Fahrbarky and Schenck, Reckenzaun and Julien type. The chief object of the experiments was to ascertain the efficiency of each type, especially for tramway purposes, and to eliminate errors in estimating the degree to which the cells had been charged or discharged. The experimenter based his investigation on three measurements; viz., the electro-motive force on open circuit, the density of the electrolyte, and the potential difference when at work. The efficiency of the Reckenzaun accumulator was found to be 89.3 per cent for quantity, and 80.5 per cent for energy. For the Julien accumulator, the figures were respectively 89.7 per cent and 83.4 per cent; whilst the Schenck-Fahrbarky accumulator gave 91 per cent efficiency for quantity, and 78.5 per cent for energy." These figures are interesting; but as the efficiency of any accumulator varies greatly with the rate of discharge, decreasing as the discharge rate increases, it would be well to give with the efficiencies the rate of discharge at which they were obtained. As the experiments were for tramway-work, however, we may assume that rather heavy currents were used: this being the case, the tests are most encouraging.

THE BENTLY-KNIGHT ELECTRIC TRAMWAY IN ALLEGHENY CITY. — This line is about four miles in length, and employs both overhead conductors and conduits. In both cases there is a complete metallic circuit, neither the rails nor earth being used as a return. The road is difficult, with one grade of 9⅜ feet in 100 feet for a distance of 400 feet, and numerous others; the average rise in a distance of 4,900 feet being 295 feet, — over six per cent. Two fifteen-horse power motors are used under each car, connected with the axles by spur-gearings. There are at present four cars running, with two more to be added shortly.

HEALTH MATTERS.

State Medicine.

AT the meeting of the American Medical Association held in Cincinnati during the present month, Dr. H. P. Walcott, chairman of the State Board of Health of Massachusetts, delivered the annual address on State medicine. For the following abstract of the address we are indebted to the *New York Medical Record*: —

Dr. Walcott first related briefly the history of the State Board of Health of Massachusetts, which was established by legislative action in 1869. Its duties were at first advisory rather than executive; but, in proportion as public intelligence in sanitary matters was quickened, the functions of the board were enlarged, until now it is charged to some extent with the power of enforcing the rights of the people to pure air, soil, water, and food, and preventing and punishing any violation of them. It is also intrusted with the business of gathering information concerning any matter pertaining to public health, and diffusing such information among the people. Among the chief of its duties in this connection is the investigation of the causes and the prevention of infectious diseases. A comparison of the mortality statistics will show in a measure the effect which all this work has had upon the health of the people. The number of deaths from all causes, in proportion to the population, has changed but little during a period of thirty-six years, ending with 1886; but the percentage of deaths from zymotic diseases has almost steadily decreased, during the period that the State Board has been in existence, from 25.6 to 19.0; there has also been a general tendency, though less marked, in the direction of a decrease of deaths from constitutional diseases. The classification of preventible diseases is as yet not well defined; and year by year, as the experience of sanitarians becomes widened, a larger and larger number of affections are found to be the result of influences that can be removed. This fact is illustrated in the case of consumption, the prevalence of which was shown twenty-five years ago by a former president of this association, Dr. H. G. Bowditch, to be largely influenced by conditions of soil, moisture, and land-drainage. The most marked reduction has occurred in the case of small-pox, which is a disease that is absolutely preventible by means of vaccination and re-vaccination. In demonstration of the saving of life in consequence of better sanitary conditions, the speaker offered a comparison between the results of ovariotomy and those following the labors of an intelligent and efficient board of health. The largest number of deaths in Massachusetts in any one year from ovarian dropsy was 51. In the single city of Somerville the death-rate has been reduced, since the organization of a municipal board of health, from 22.86 to 16.68 per thousand. Thus the adoption of sanitary measures has saved more lives in one year, in a community of thirty thousand people, than could have been restored to health in the same period in a State of nearly two millions of inhabitants, by an operation which is justly regarded as one of the greatest triumphs of American surgery. In has been said by Dr. Russell of Glasgow that nothing is more conspicuous than the helplessness of the individual, under the conditions of civilized life, to secure the physical basis of health. How can any single individual in a crowded city detect and remove all possible causes of disease in the water, food, sewerage, and air contamination? There is no help but in co-operation on the most extended scale possible, — individual, municipal, State, and national. The individual must be compelled to give up the liberty to injure his neighbor; the city must be restrained from converting into a sewer the river which supplies water to the villages that cluster about its banks lower down in its course; no State should permit its own causes of disease, whether they are persons or things, to be transported into another State; lastly, the general government should take cognizance of those causes of disease which can be controlled by no other power. A sufficient safeguard will never be established by voluntary associations on the part of persons, towns, States, or even nations. How, then, shall we organize for the protection of the public health? For the individual, the speaker maintained: "Let the State give him some assurance that the legally used title of physician designates a person sufficiently qualified to give advice for the prevention and cure of disease; establish, by direct provision of State law, local health authorities for each village, town, city, or county; and, to control all these local organizations, let there be a State board, clothed with ample powers." All arguments that have been used for the existence of State health authorities, Dr. Walcott believed, are also available for the creation and support of some central health authority. The question of form of this organization is one that may be left to the law-making powers. A board in which every State was represented might be cumbersome, but it could easily delegate its powers to a small and compact executive committee during the intervals between the necessarily infrequent meetings of the full board. The only alternative to this seemed to the speaker to be a single officer at the head of a bureau in connection with some one of the departments at Washington. This central authority, however constituted, should have ample means for investigating into the State boards of health. There is still in legal existence a national board of health; but, through the neglect of Congress, it is in a state of hopeless lethargy. This board entered upon its work with every promise of success, and it demonstrated that local, State, and national health authorities could profitably and harmoniously unite in suppressing an epidemic of yellow-fever, and preventing its spread from State to State; yet this did not save it from practical extinction. The failure of the board to survive the unjustifiable attack made upon it was due in great measure, the speaker thought, to its organic form, embracing, as it did, members